AMATEUR RADIO

73

OCTOBER 1976
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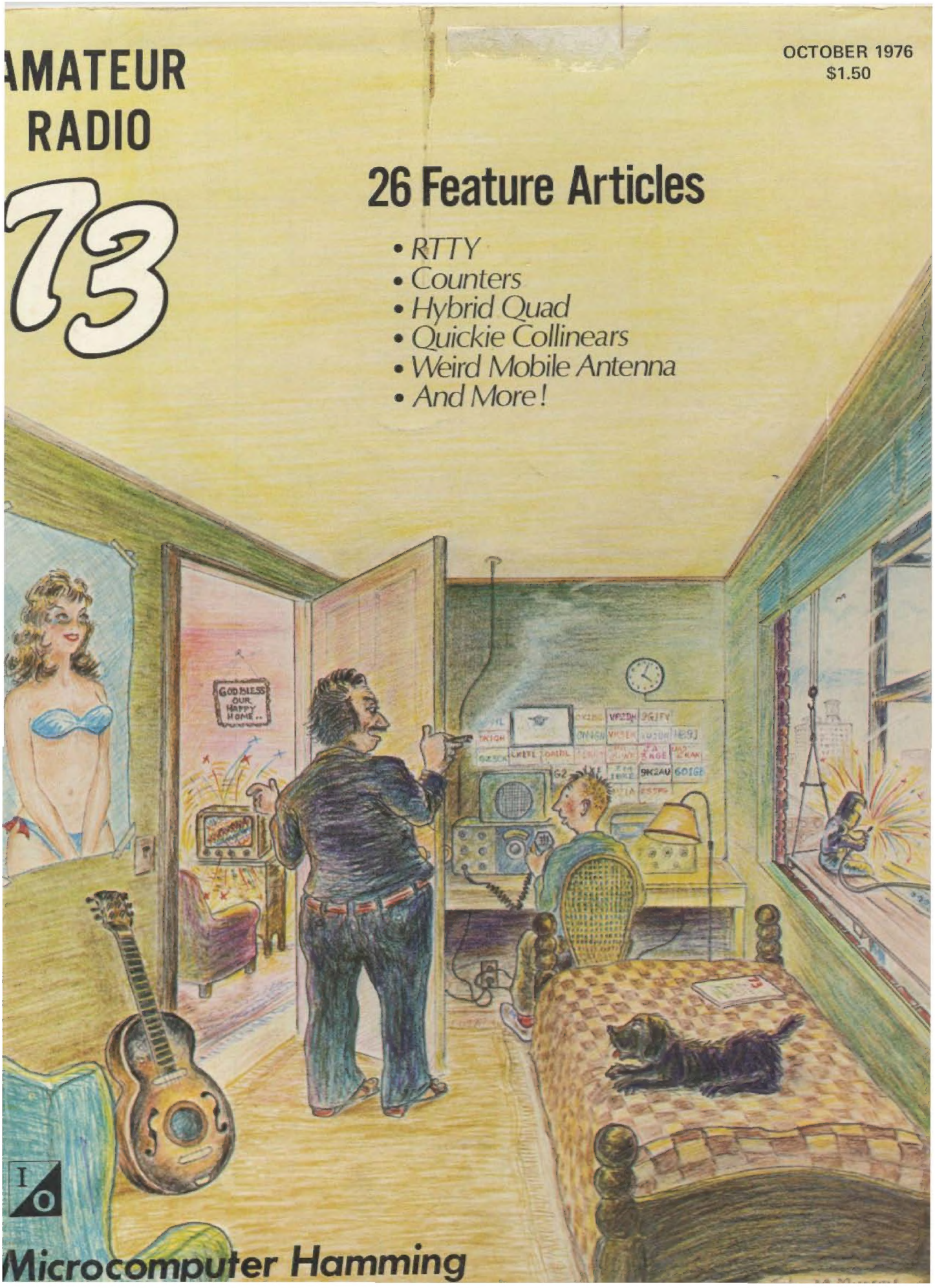
26 Feature Articles

- *RTTY*
- *Counters*
- *Hybrid Quad*
- *Quickie Collinears*
- *Weird Mobile Antenna*
- *And More!*



Microcomputer Hamming

Steve Ciarcia
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Hey, Look What My Daddy Built!

-- six TV game chip can make you a hero

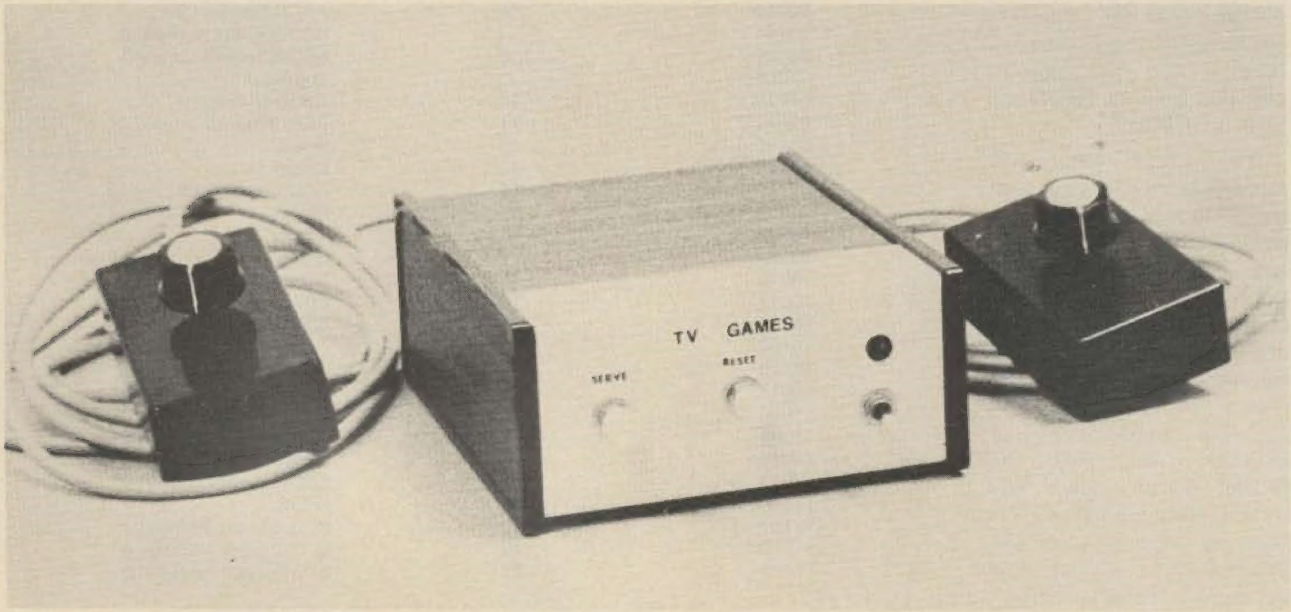
"Wilbur, can't you keep those damn kids quiet while I'm making dinner?" How many American husbands have heard that? If this were the opening block on the "wordless workshop" home improvement cartoon feature found monthly in *Popular Science* magazine, the next six cartoon blocks would illustrate the construction of a giant bird cage or ski jump for the backyard to entertain the kids. This is a nice idea, but there are very few things which are universally entertaining to children, or adults for that matter – except maybe the boob tube. Today's generation of children has grown up spending more time in front of a television than in school. The TV has become a cheap babysitter and the primary source of entertainment for most American families.

Wilbur, trying to keep peace in the family, scans the TV listings and sees that he has a choice of Peyton Place reruns, a subtitled movie in Swahili and Jimmy Durante doing impressions of Walter Cronkite. His only wish at this point is that the TV set would show something that he wanted rather than what Smell-o Deodorant or Slippery Lip Ice Cream was willing to sponsor.

Wilbur checks his *Popular Science* and considers the cartooned suggestions, but decides that he might enjoy the bird cage idea too much and the ski jump would attract more noisy kids. In his continuing search through the magazine rack, he spies an article describing the construction of a TV ping pong game and decides this may be the answer to his problem. Such a system would use his existing TV – no re-education necessary – and all parts are available from a supplier listed in the article.

Wilbur spends his $140 and obtains a kit by mail a month later. He carefully lays out all the parts for the basic game plus the optional scoring board and power supply: 90 TTL ICs, assorted resistors, capacitors and hardware. His wife surveys this and pipes in with, "Do they sell that junk by the pound?"

Completely undaunted, Wilbur spends the next week, three telephone calls to the kit manufacturer, and one very expensive and frustrating visit to a TV repairman for him to set and align all the timing circuits. The kids have been thoroughly entertained in the meantime watching



Game circuit built by author.

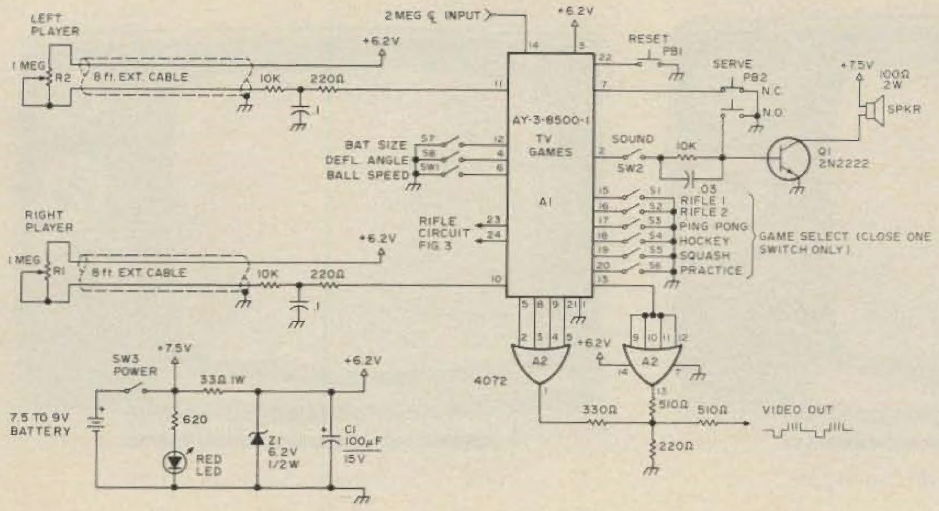


Fig. 1. TV game schematic.

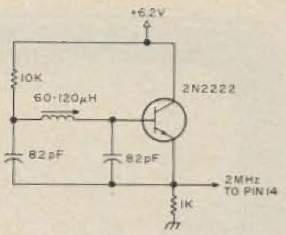


Fig. 2. 2 MHz oscillator. Miller 9055 miniature slug-tuned coil; all resistors ¼ W 5%; all caps min. 25 V ceramic.

Daddy cuss each individual component as he assembled the massive board.

Then came the moment of truth. Power on. It would be unfair to say that it didn't work. It did work and the kids were completely occupied for about three weeks. They then got tired of just bouncing the ball back and forth in the same ping pong game all the time. "Wilbur, can't you keep those kids quiet while I'm making dinner?" ARRRRG!

This painfully familiar story serves as our introduction to the world of TV games. There are TV games sold in every discount store and almost every major electronics periodical has had a construction article on them. The commercial units cost between $75 and $100 and the construction kits are about the same cost, but there are considerable differences among them. Some may be using older designs which may have as many as 100 chips to perform only one game, or at the other extreme one chip to perform six games. Obviously, Wilbur would have been better off buying a unit which performed more than one game and allowed variations within each. Fewer parts would necessarily mean a lower price and increased reliability.

The ultimate in perfection (so far) is the subject of this article: the AY-3-8500-1 made by General Instruments. This is a 24 pin MOS integrated circuit TV game chip capable of playing six different TV games. The features are as follows:

1. Six selectable games — tennis, hockey, squash, single player practice, and two rifle shooting games
2. Automatic scoring
3. Score display on TV screen: 0-15
4. Selectable bat size
5. Selectable ball speed
6. Selectable deflection angles
7. Automatic or manual ball service
8. Realistic sounds
9. Shooting forwards in hockey game
10. Visually defined playing area for the four ball games

Game Descriptions

TENNIS:

The tennis game picture on the TV screen will be as shown in Fig. 5. There will be one bat or player per side, a playing field boundary and a center net. Scoring position is as illustrated. After reset is applied, the score is 0 to 0 and the ball will serve arbitrarily from one side toward the other. It is the opposing player's objective to intersect the path of this ball and deflect it back toward his opponent. If no intersection occurs, a point will be automatically scored against the erring player and the ball will again be automatically served toward him again. Serve will not change until he scores a point and gains the advantage. A game concludes when one player's score totals 15 points.

The exact details of the game are a function of the optional speed, size, and

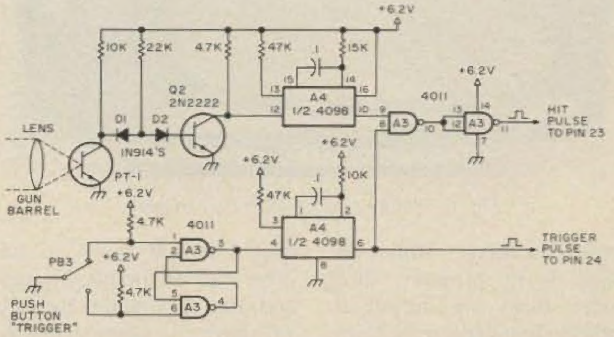


Fig. 3. Rifle circuit. PT-1 — phototransistor TIL64 or equiv.; 4098 — dual monostable; 4011 — quad 2 input NAND; all resistors ¼ W 5%; all caps min. 25 V dc ceramic.

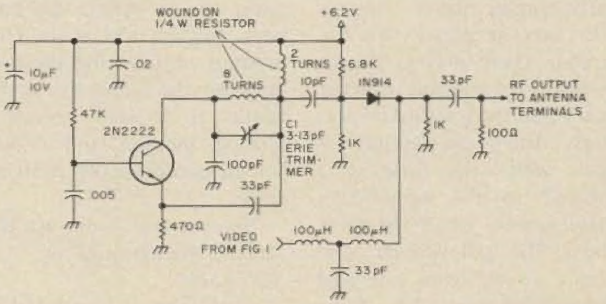


Fig. 4. VHF modulator sample circuit. All resistors ¼ W 5%; all caps min. 25 V ceramic unless otherwise noted. NOTE: THIS IS AN ILLUSTRATION OF A SAMPLE VHF MONITOR. THIS CIRCUIT HAS NOT BEEN APPROVED BY THE FCC.

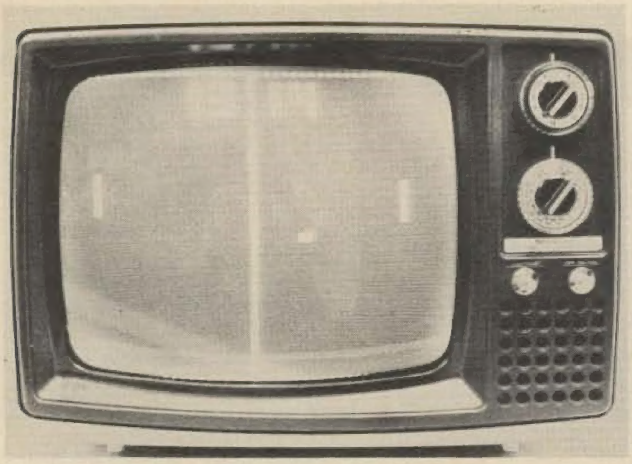


Fig. 5. Tennis game with ball in play.

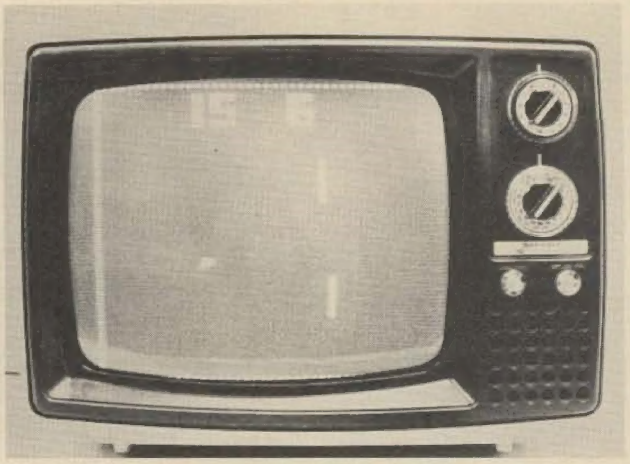


Fig. 7. Squash game with ball in play.

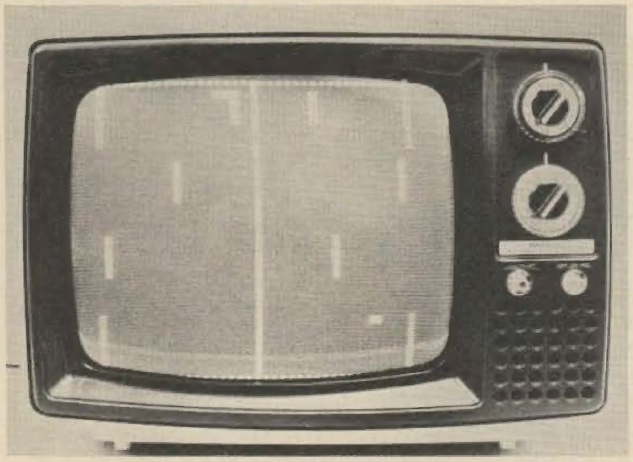


Fig. 6. Hockey game with ball in play.

angle selections. While the game is in progress, three audio tones are output to indicate boundary reflections, bat hits and scores.

HOCKEY:

The rules of the hockey game are exactly the same as the tennis game except that each human player controls two bats or players on the screen. These players shown in Fig. 6 are referred to as the goalie and the forward respectively. The goalie defends the goal, while the forward is located in the opponent's playing area. When the game starts, the ball will be arbitrarily served from one goal toward the other side. If the opponent's forward can intercept the ball, he can shoot it back toward the goal and score a point. If the ball is missed it will travel to the other half of the playing area and the opponent's forward will have the opportunity to deflect the ball toward the goal. If the ball is "saved" by the goalie or it reflects from a boundary, the same forward will have an opportunity to again try to deflect the ball back toward the goal. This method of jamming the ball between the forward and the goalie is a very effective scoring method and makes for an exceptionally exciting game.

Scoring and audio are the same as the tennis game.

SQUASH:

This game is illustrated in Fig. 7. There are two players who alternately hit the ball against a back court boundary.

Scoring and audio are the same as the tennis game.

PRACTICE:

This game is illustrated in Fig. 8 and is similar to squash except that there is only one player.

RIFLE:

The rifle game is illustrated in Fig. 9. Rifle 1 game results in a large target which randomly shoots across the screen while Rifle 2 requires that the target bounce around within the area defined by the TV screen. External circuitry listed in Fig. 3 conditions optical input to a photocell located in the barrel of a toy pistol or rifle which is aimed at this random target. When the trigger (PB3) is "pulled," the shot counter is incremented. If the rifle is on target, the hit counter is incremented.

After 15 shots the score is displayed.

Circuit Description

The simplest circuit utilizing this game chip is illustrated in Fig. 1 and shown in the photo. A DIP switch (S1-S8) is used for rarely changed functions such as game selection, rebound angle and bat size. A $2.00 eight section switch such as this serves to lower overall costs by replacing about $8.00 worth of toggle and rotary switches while maintaining miniaturization. S1 through S6 are the game selection switches. Only one of the switches is enabled or placed in the ON position. The others must be left open or the game chip will try to play more than one game simultaneously. The correct procedure for selecting a game is to turn the currently programmed game off (all six switches open) and then close the particular switch for the desired game. Switches 1 through 6 will select the following games respectively: Rifle 1, Rifle 2, tennis, hockey, squash, and practice.

Bat size and ball deflection angle are controlled by DIP switch sections S7 and S9 respectively. With S7 open the larger bat size is selected. On a 21" television screen this will appear to be about 2". When this switch is in the closed position, small bats of approximately half the previous size will be displayed. All paddle game photos in this article illustrate the large bat selection.

When first playing a TV game, a player may want to find his bearings and fine tune his eye-hand coordination. For just this reason General Instruments provided for selectable bounce, or deflection angles. When S8 is open, three rebound angles are enabled – plus and minus 20 degrees and straight back

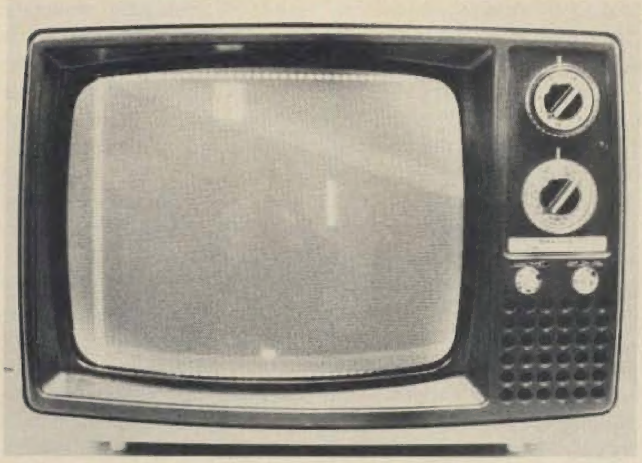


Fig. 8. Practice game with ball in play.

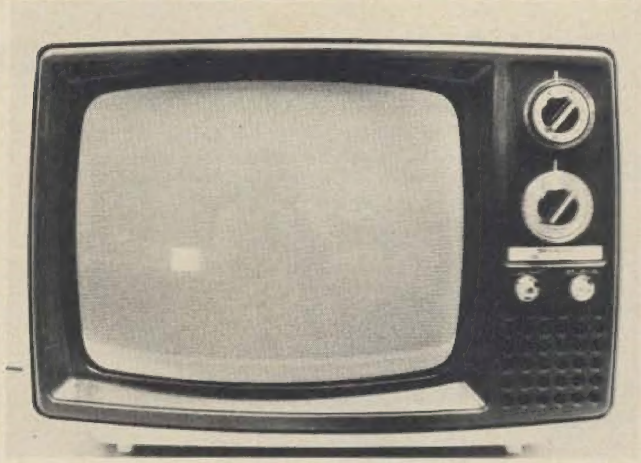
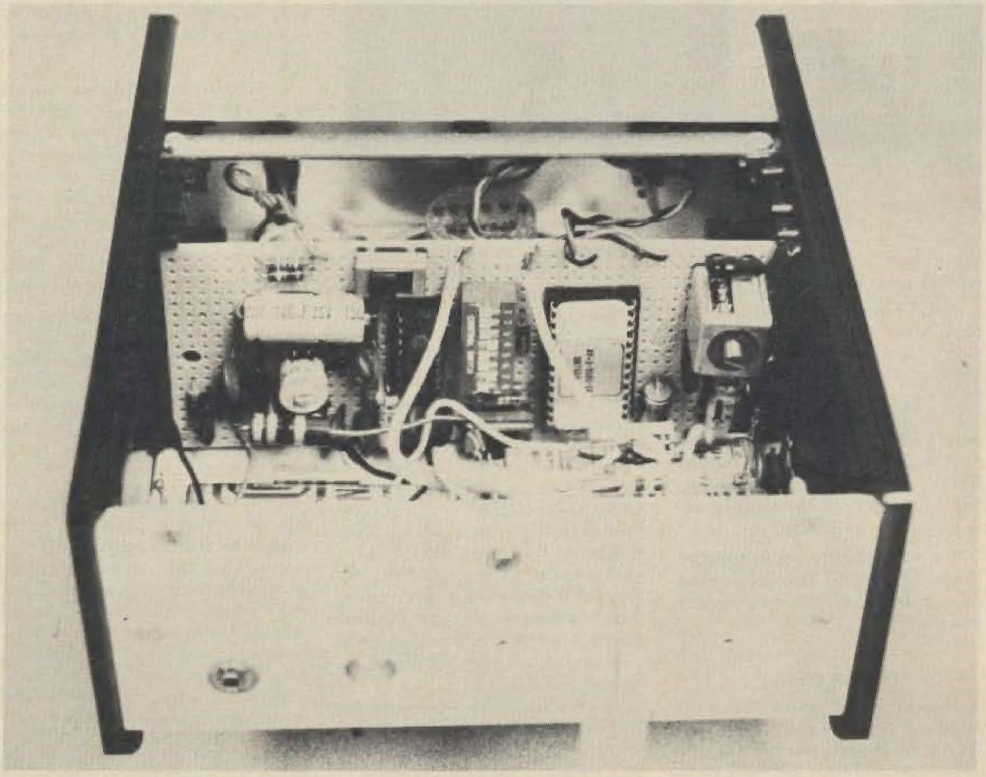


Fig. 9. Rifle games 1 and 2 target.

at 0 degrees. With S8 closed, five rebound angles are possible – plus and minus 20, plus and minus 40, and 0 degrees. This latter selection requires considerable player skill and dexterity and adds new dimensions to otherwise repetitious games. If that were not enough, selectable ball speed is also available. The ball speed switch SW1 is used more often than the game select switches and therefore should be a more easily used slide switch. When this switch is open, low speed is selected. In this mode the ball takes 1.3 seconds to traverse the screen. When the switch is closed, high speed is chosen and the ball will dart across the screen in .65 seconds. There is a complete understanding of the concept of human fallibility after playing a game which combines small bat size, full rebound angles, and a fast ball speed. With this combination, the cure for boredom becomes electronically induced insanity.

If these features were not sufficient, there are more – realistic sound and automatic scorekeeping. All games consist of 15 points with both players starting with a score of zero after pushing the game reset button (PB1). With pin 7 grounded through the manual serve push-button (PB2), play will resume automatically upon the release of the reset button. Automatic start is signified by the game ball being arbitrarily served into the playing area, and each time a point is scored, the ball will come into play into the court defended by the player having scored the point. If automatic start is not desired, the reset and serve buttons should be pressed simultaneously when resetting a game. The reset button is then released while still depressing the serve button. This will allow complete player readiness and will only put the ball in play when the serve button is finally released. Score is incremented (up to a high of 15) each time a player fails to deflect a ball away from goal.

All of this rebounding and scoring results in some very interesting game sounds. A ball hit upon a paddle results in 32 milliseconds of 976 Hz tone. A boundary reflection is 32 milliseconds (msec) of 488 Hz tone and score is 160 msec of 1.95 kHz tone. This square wave oscillation is amplified by a 2N2222 transistor and applied to a 100 Ohm .2 Watt speaker. (An 8 Ohm speaker may be used with proper current limiting in the collector circuit.) SW2 is provided to switch off the sound without having to shut off the game. Player positioning is remotely controlled through cables attached to pins 10 and 11 of the game



Inside of author's game unit illustrating parts layout.

Parts List for Figs. 1 and 3.

A1	AY-3-8500-1 MOS game chip General Instruments
A2	4072 Dual 4 input OR gate CMOS RCA
A3	4011 Quad 2 input NAND CMOS RCA
A4	4098 Dual monostable CMOS RCA
Q1, Q2	2N2222 or equiv.
S1-S8	8 position DIP switch Gray Hill or equiv.
PB1, PB3	SPST momentary push-button C & K Subminiature
PB2	DPST momentary push-button C & K Subminiature
SW1, 2	SPST slide switch Alco Subminiature
SW3	SPST toggle switch C & K Subminiature 3 A 115 V ac
PT-1	TIL 64 phototransistor or equiv. Texas Instruments
D1, D2	1N914 diode Texas Ins.
C1	100 uF electrolytic 15 V dc
Z1	1N753A or equiv.
R1, R2	1 meg composition potentiometer 2 Watt Allen-Bradley or equiv.
SPK	100Ω .2 Watt speaker
LED	NSL5053 LED or equiv.

All resistors are ¼ Watt 10% unless otherwise indicated.
All capacitors are ceramic type with min. voltage ratings of 25 V dc unless otherwise indicated.
MISC extension cable, batteries, box, hook up wire, etc.

chip. Each player control consists of a 1 meg pot and .1 microfarad capacitor which combines to form a variable time constant utilized by internal timing circuitry. Longer or shorter time constants will result in relatively different vertical player positions. To reduce noise, this extension cable should be shielded; otherwise, a display malady referred to as "herringbone effect" will result.

For a TV game to be properly displayed on a raster scan television, the proper video signal, similar to that of any commercial TV station, must be applied to the antenna. Such a video signal results from synchronized dividers inside A1, which divide the 2 MHz master clock (Fig. 2) and output the required 60 Hz vertical and 15750 Hz horizontal sync signals. These signals from pin 13 are combined with those of the ball output, right player output, left player output, and score and field output (pins 5, 8, 9, and 21 respectively) in a two bit digital to analog converter formed with a 4072 CMOS dual 4 input OR gate. This type of video output is referred to as composite video output and is suitable only for use on video monitors and not standard televisions. This video output may in turn be used to amplitude modulate an rf carrier suitable for a standard television receiver. Fig. 4 illustrates a sample circuit of this basic type of modulator. With the components chosen, the frequency is approximately that of VHF channel five. (This circuit is intended for illustration only and acceptability by the FCC as a proper class 1 rf modulator is not inferred.) The modulator output is connected directly to the TV antenna terminals, with the antenna disconnected, and adjusted for the best reception.

This game is a marvel of engineering ingenuity through which General Instruments has succeeded in enlightening the average American to the latest advances in electronic technology. It is easy to overlook 16K bit RAMs and microprocessors, but it is hard to ignore such a marvelously exciting TV game when presented on your own home television. ■

EDITORIAL BY WAYNE GREEN

from page 4

system that is just like RTTY, but with the break-in feature.

If RTTY operators wanted to, they could have break-in just by setting up their systems on two different frequencies. Then they could use a split CRT display such as Don Alexander has developed (August, page 82), to show both what they are sending and what they are receiving on the top and middle of the tube. If anyone gets into this I'd like to know about it, and so would a lot of RTTYers.

Not a few readers would probably like some hints on how to get their code speed up to 100 wpm . . . any volunteers?

UNEMPLOYED?

The politicians are talking a lot about jobs, yet here at *73* we have jobs going begging. We need help in several departments and would be absolutely delighted to have some hams come up here to fantastic New Hampshire to join us.

If you read *Newsweek*, you know that New Hampshire has one of the lowest tax rates in the country, yet provides very good services for the people. It has one of the lowest accident rates in the country on its roads. This despite the large influx of visitors who come to New Hampshire on vacation . . . four seasons of the year. We have large vacation crowds in summer when it is cool and beautiful. We have them in the spring when it is fantastically colorful and fresh. We have them in the fall to see the finest foliage in the world (except for a small part of Northern China where they have similar acid earth which generates these colors) . . . and winter! Winter is the best season of them all . . . not too cold, but with snow for the many ski slopes.

For the ham, New Hampshire has two major advantages . . . one is rarity . . . New Hampshire has few people so you are almost like DX on many of the ham bands. And, if you are into FM, the myriad of mountaintop repeaters throughout the state will keep you busy. You will be hard put to keep from finding a mountain for yourself.

In southern New Hampshire we are not too far from Boston . . . for plays and concerts . . . and a major airport for travel. Yet we are in the country. Peterborough is one of the most beautiful towns in New England. Even though it is very small, it is a shopping center for this part of the state, with downtown shopping and two shopping centers on the outskirts of town.

We have grown considerably during the last year at *73* . . . with circulation up over 30% since January and headed for a 50% increase by the end of the year. Advertising has increased almost 50% in the past year. The staff has almost doubled and there is still a need for more.

While we can use people with printing or magazine experience, the biggest demand is for editors. We need two or three more, at least, if we are going to continue to grow and put out more books and magazines. We are looking for hams with as much experience in hamming as possible . . . hopefully with good technical backgrounds . . . who are into working more than clock-watching.

We have a dozen books in the works for release soon and we would like to increase this to a hundred . . . if only we had the hams to help get them ready for printing. We'll need help with getting a new CB magazine started . . . and with a new hobby computer magazine. We need a lot more help in getting *73* out each month. We need help in marketing the books, magazines and tapes . . . through direct mail, dealers, newsstands, reps, etc. The more readers we get, the more people will be able to enjoy the magazine every month.

If you have the background, a bunch of enthusiasm, are a self-starter and don't have to be told what to do . . . if you like working in a very unusual and relaxed atmosphere, . . . if you are work-oriented . . . if you would like to live in a beautiful part of the country . . . you can do worse than let us know about it.

A GOOD BOOK

A good book indeed is the *Handbook for Electronic Engineering Technicians*, for $19.50. The price is high, but this is an excellent book and well worth the investment. The material is a bit brief for the book to be used strictly as a study guide, but as a handbook . . . as a reminder of how just about everything you'll run into in electronics works, it is superb. The math is kept to an absolute minimum and every subject is covered concisely. McGraw-Hill. If you are at all serious about understanding electronics, you just can't do without this new book.